II. Vertical Profile of our Atmosphere

Learning Objectives

Students will:

- Learn about the vertical profile of the Earth's atmosphere
- Plot distances (heights) on a graph

Estimated Time:

1 hour

Materials:

- Blank Vertical Profile of the Atmosphere Graph
- Vertical Profile of the Atmosphere Graph with Pictures
- Information Cards on Reference Objects
- Information Cards on Layers of the Atmosphere
- Computer to view video, Ground to Space [http://mynasadata.larc.nasa.gov/images/Video of Atmosphere-Ground to Space.mov]

Vocabulary:

- **Atmosphere**- - the mixture of gases that surrounds the Earth and some other planets. The concentrations of the gaseous constituents of Earth's atmosphere are determined by biogeochemical processes, including manmade effects.
- **Altitude**- the vertical distance or height measured from sea level.
- **Cloud**- collections of water (in liquid or ice phase) in the atmosphere that are often classified by their shape and height. http://science-edu.larc.nasa.gov/SCOOL/cldchart.html (cloud chart)

Background Summary:

The Earth is surrounded by a blanket of air, which we call the atmosphere. It can reach beyond 700 kilometers (435 miles) from the surface of the Earth, but we are only able to see what occurs fairly close to the ground. Almost all of the Earth's weather occurs in the layer closest to the ground. Life on Earth is supported by the atmosphere, solar energy, and our planet's magnetic fields. The atmosphere absorbs the energy from the Sun, recycles water and other chemicals, and provides a moderate climate. The atmosphere also works with the electrical and magnetic forces to protect us from high-energy radiation and the frigid vacuum of space.

The envelope of gas surrounding the Earth changes from the ground up. Four distinct layers have been identified using thermal characteristics (temperature changes), chemical composition, movement, and density. The layers from the ground up are: troposphere, stratosphere, mesosphere, and thermosphere. The upper limit of the thermosphere is referred to as the exosphere. This is where the Earth's atmosphere blends into space. The altitudes of the atmospheric layers are not constant. They vary depending on the season and location on Earth, so other images showing the layers of the atmosphere may have different heights. The image displayed on the ***Vertical Profile of the Atmosphere Graph with Pictures*** predominantly uses the maximum height the layers can reach.

In this activity students will plot these atmospheric layers on a graph. To help give students an idea of just how far up the layers of the atmosphere are, students will also plot man-made objects that fly (or orbit) in the layers.

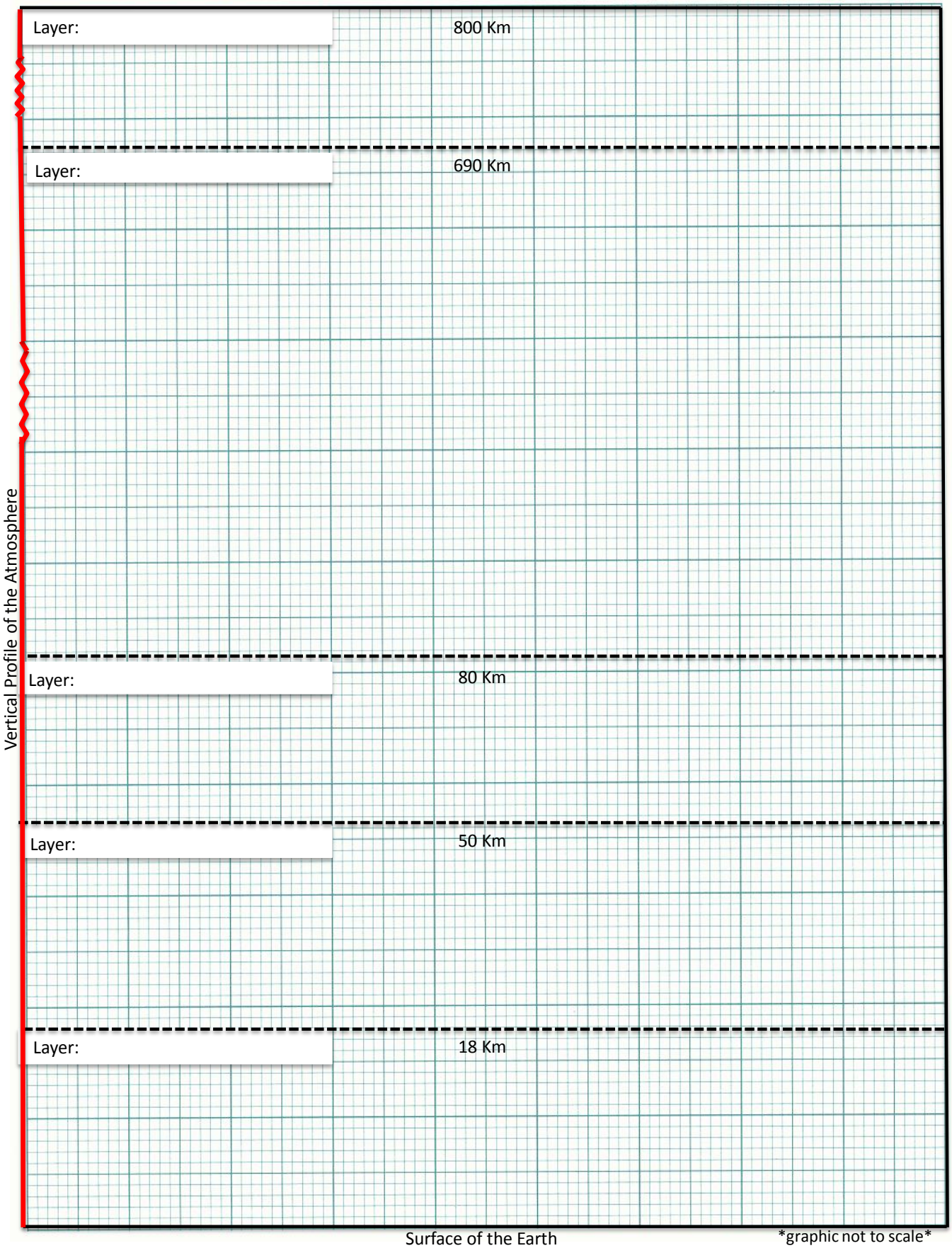
Steps:

1. Ask students how high up does the atmosphere go? What is the highest distance in the sky they have ever been?

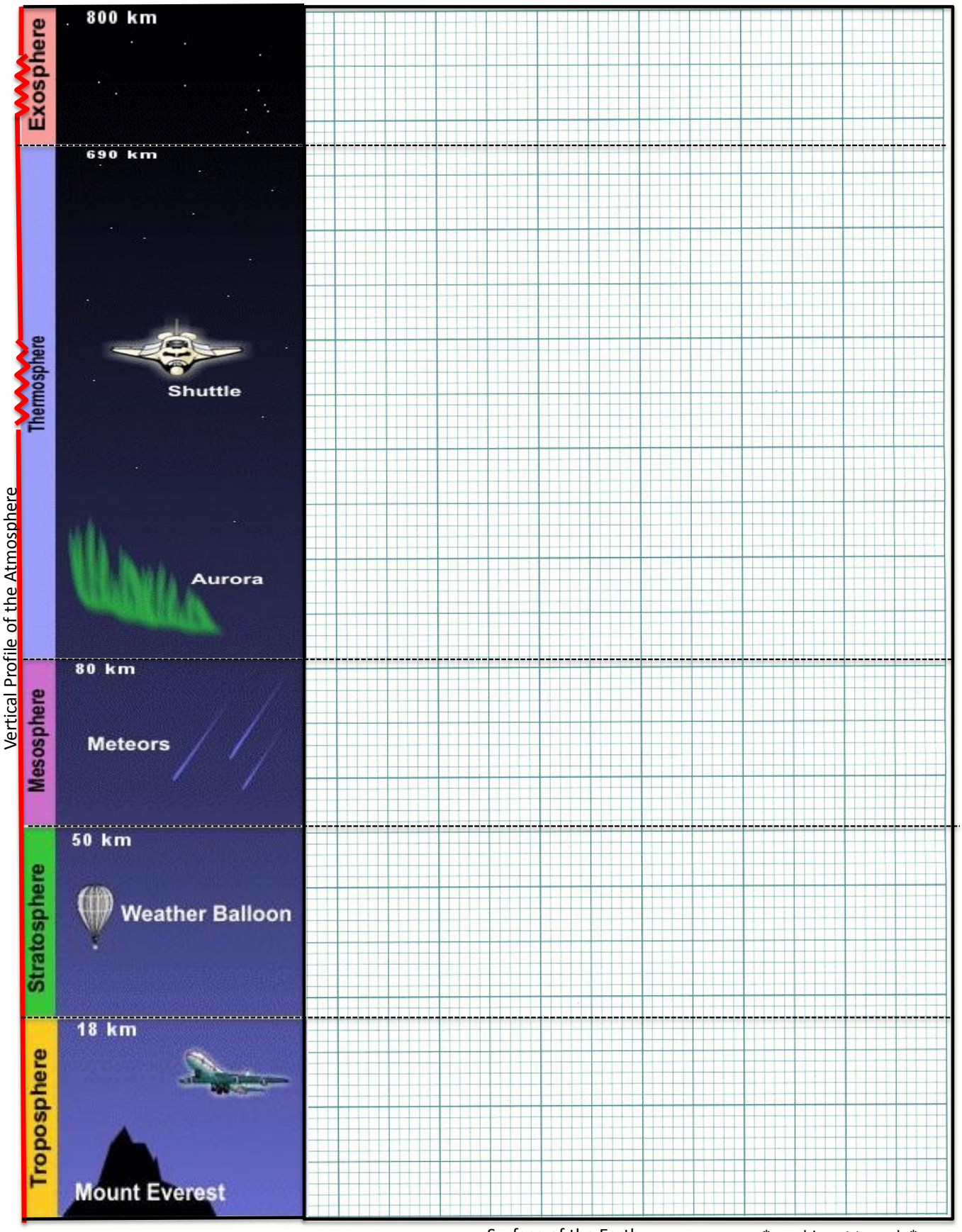
2.* Discuss with the students that they are going to see a short video of the sky from the ground all the way up to space. We call all of this air, the atmosphere. The atmosphere is another name for the air around us. Show students the video, ***Ground to Space***. Ask students about what they saw in the video. * If the classroom does not have adequate equipment to display the video, discuss the term "atmosphere" and move to step 3.

3. Show on an overhead the ***Blank Vertical Profile of the Atmosphere Graph***. Discuss how the graph the students will draw represents the vertical profile of the atmosphere. Teachers may wish to have a class graph for reference so at the end of the activity students can see what the graph should look like. If students have not created graphs before, or are not familiar with the X- and Y-axis, discuss how this is a way to visually display information or data.
4. Ask students what features they could draw on this graph to show the atmosphere from the ground up. If students saw the video, ask them to think about the objects or features they saw in the video (i.e., cumulus clouds, airplanes, cirrus clouds, weather balloons, space shuttle).
5. Tell the students that they are going to receive a set of cards with objects/features they might want to use for the graph. Pass out the ***Information Cards on Reference Objects***. In pairs or small groups, have students look at the pictures. Ask the students to put the pictures in the order they think they would see them from ground to space.
6. Once groups have ordered their pictures, have the groups compare their order. If any pictures do not match with another group's pictures, ask the groups to explain why they put the items in that order. On the board, display the correct order of the items and their height. (If cards are printed with the descriptions on the back, students can turn the cards over to find the altitude.)
7. Pass out a ***Blank Vertical Profile of the Atmosphere Graph*** to each student. Ask students to select objects/features to draw on their own graph. Once students begin selecting items that they want to draw on their graph, ask them where on the graph the items will be drawn (check to make sure height makes sense). To get the students started, teacher may want to begin by leading the class to draw a reference feature on the ground (i.e. Mount Everest).
8. Pass out the ***Information Cards on the Layers of the Atmosphere***. On each student's graph, have students label the layers of the atmosphere corresponding to the appropriate altitude. Teachers may wish to assign each student group a particular layer of the atmosphere and present information about the layer's altitude and characteristics to the class.
9. Discuss where weather happens (the troposphere). Weather is happening all the time around us. Ask students for some examples of 'weather'? (Temperature, precipitation or rain, storms, tornadoes, or clouds) Ensure that students have included a cloud (or clouds*) on their graph representing the layer where weather occurs.
* If students are familiar with cloud types and the three levels of clouds, have students draw a cloud for each of the three levels. Ask students what type of cloud they drew and how they determined where to draw it on their graph. – See S'COOL Tutorial: *Clouds* at: http://science-edu.larc.nasa.gov/SCOOL/tutorial
10. Checking for Understanding: Have students share their graph and explain the levels and objects drawn on the graph. Have students explain why they drew items at particular spots on the graph. Once students have shared about their graph, show the class the picture of the ***Vertical Profile of the Atmosphere Graph with Pictures*** and have students compare this image with their graph. Did they draw an airplane, weather balloon, or shuttle in the same layer displayed in the picture?

Blank Vertical Profile of the Atmosphere Graph



Profile of the Atmosphere Graph with Pictures



To make cards:

1. Print card pages 6-8
2. Cut across horizontally so title box (front) and description box (back) are on same sheet
3. Fold each sheet in half down the middle
4. Tape the front and back of each sheet together

Exosphere	- The highest layer of the atmosphere - This layer often considered an extension of the thermosphere - Extends from the top of the thermosphere up to 10,000 km - The atmosphere here merges into space Objects Orbiting in this Layer: Satellites
Thermosphere	- Outer layer of the atmosphere - Extends from the top of the mesosphere to over 640 km - The lower part of the thermosphere, from 80 to 550 km above the Earth's surface, contains the ionosphere Objects Orbiting in the Layer: Space Shuttle & International Space Station Features: Aurora
Mesosphere	- The third highest layer in our atmosphere, above the stratosphere and below the thermosphere - Extends from the top of the stratosphere to the range of 80 to 85 km Features: Occasional meteors
Stratosphere	- The second lowest layer of Earth's atmosphere - Extends from the top of the troposphere. to about 50 km Objects Flying in this Layer: Weather Balloons Features: Ozone Layer
Troposphere	- The lowest layer of Earth's atmosphere - Extends from Earth's surface up to 7 km at the poles, and about 17-18 km at the equator Objects Flying in this Layer: Airplanes Features: Most weather happens at this level - Clouds, rain, hurricanes

Cumulus Clouds

Cumulus Clouds- Low level clouds that appear puffy or look like cotton balls. They are made up of tiny water droplets.

Altitude of Low-level Cloud Base: 0-2km

Cirrus Clouds

Cirrus Clouds- High level clouds that are made up of ice crystals. They can be thin and wispy or look more like streamers.

Altitude of High-level Cloud Base: 5-15km

Airplane

Airplane- A machine that uses an engine to make it fly. These vehicles can fly low to the ground or above 9,000 m. The curved top of the wings of an aircraft helps airplanes to fly, even though an airplane is much heavier than air.

Altitude: 9 km

Space Shuttle

Space Shuttle- A reusable spacecraft designed to take people and cargo between Earth and space. It is made up of the external tank, two solid rocket boosters, and the orbiter with the three space shuttle main engines. Once in space, the shuttle orbits the earth at about 300 km.

Altitude when Orbiting Earth: 300km

Weather Balloon

Weather Balloon- Weather balloons are launched from Earth and rise through the air. A box attached to the bottom of the balloon contains instruments, which record the weather conditions of the atmosphere including air pressure, temperature, wind speed, and wind direction.

Maximum Altitude: 40 km

Satellite

Satellite- An artificial satellite is a manufactured object that continuously orbits the Earth. People use them to study space, help forecast the weather, transfer telephone calls over the oceans, assist in the navigation of ships and aircraft, monitor crops and other resources, and support military activities.

Altitude of Polar Orbiting Satellites: > 700 km

Rocket

Rocket- A rocket can produce about 3,000 times more power than a car engine of the same size. People use rockets mostly for scientific research and space travel. Rockets are also used to launch unmanned spacecraft and satellites into a circular path, called an orbit, around the Earth.

Altitude: Used to Launch Satellites into Low-Earth Orbit (300km) to Geosynchronous Orbit (35,000km)

Meteor Shower

Meteor Shower- Bright streak of light that appears in the sky. Often called shooting or falling stars. Meteors appear when a chunk of stony matter, called a meteoroid, enters Earth's atmosphere from outer space and our atmosphere heats it up so much that glows.
Altitude at which Meteors become Visible: 40 to 75 km

Aurora

Aurora- A display of light in the sky due to solar wind. Most auroras occur in far northern and southern regions. An auroral display in the northern hemisphere is called the aurora borealis or northern lights. In the southern hemisphere it is called the aurora australis.

Altitude: 100-300 km

Moon

Moon- The Moon is Earth's only natural satellite and the only astronomical body other than Earth ever visited by human beings. The moon is the brightest object in the night sky but gives off no light of its own. Instead, it reflects light from the sun.

Altitude: The average distance from the center of Earth to the center of the moon is 384,467 km